Sapphire Laser doped with Ti:Al_2O_3 Titanium Ions shaped with the advanced multi-criteria analysis

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Abstract: In this paper it was used the advanced multi-criteria analysis technique obtaining remarkable results in the comparative evaluation of more alternatives to the sapphire laser doped with Ti: Al_2O_3 trivalent titanium ions, different types of rankings, the design of some technical inventions, the calculation determining the weight of a criterion, offering an N mark, the matrix of consequences.

Key-Words: laser spectroscopy, resonant cavity, sapphire doped.

1 Introduction

In this paper I studied three themes in which the Ti:Al_2O_3 laser is involved for the scientific and experimental research.

Theme 1: Titanium-Sapphire laser device – The sapphire laser materials doped with titanium ions have demonstrated that this laser is tunable due to the power of the CF crystalline field. Moulton was the first to design a Ti: Sa laser device, and subsequently much successful research has been done leading to the improvement of the laser bunch affordability, there have been written many works on laser spectroscopy, parameter calculus of CF crystalline field, power levels determination of titanium ion with the help of more models, the power of the crystalline field etc. The research idea takes into account the improvement of laser device with a mirror system which amplifies the incident radiation in a resonant cavity.

Theme 2: Laser Guidance. The guidance systems of rockets, spaceships and satellites rely on the laser. The computerization and ability of laser adjustment can open new perspectives in separating isotopes regarding nuclear weapon design. There are states preoccupied with the development and research of weapons and laser technology which cause a lot of trouble to the NATO countries which invest big amounts of money in the research based on laser technique.

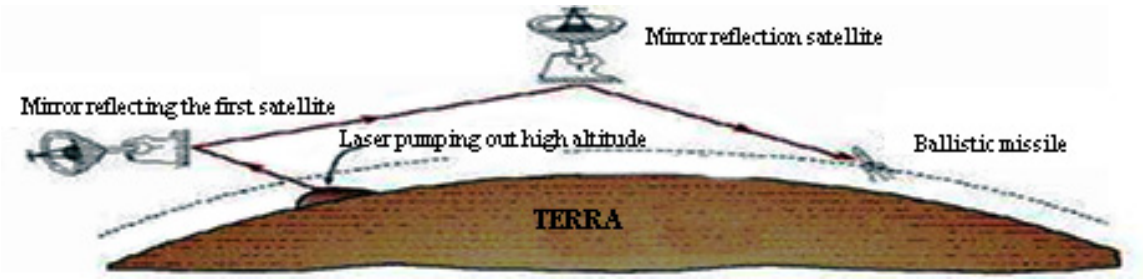

Fig.1 A defense system based on the emission of laser radiation.

In figure 1 it is shown a defense system based on the emission of laser radiation by a powerful laser device to meet two transfer mirrors mounted on two military satellites which spin and reflect the laser radiation in order to destroy an enemy rocket. Such a defense system is efficient in case 30 ballistic rockets were launched on the military base in the Pacific Ocean.

Theme 3: Hercules Laser.

Professor Karl Krushelnick from Michigan University who significantly contributed to the design of this laser in which the light is collimated through a system of mirrors and other optical elements obtains a laser radiation with the Hercules project having the intensity twice as big in magnitude as the existing lasers which is comparable to the Sun radiation and which is concentrated through a giant magnifying glass into a grain of sand (SiO_2) on Earth.

In reply the professor used the scientific phrase "I do not know any other place in the universe which has such an intensity of light. We believe it is a record." The characteristics of this laser are impressive and I do not think they will be outrun in the next period: depopulation takes place in a Δ t=10^{-15}fs, power P =300 terawatt, intensity I=20 billion trillion watts/$cm^{2.}$ The professor's technique is based on the idea of stocking energy and releasing it almost immediately.

I think that HERCULES results must have impressed physicist Stephan Hawking, too, especially due to the delicate references to the universe. He is impressed with the evolution of the computerization way produced by man: the information in a black hole is not lost.

2 Discussions

The justification of choosing this theme is based on the study of Hercules laser in order to obtain different results: streams of protons and electrons for the cancer treatment using eradiation.

In the military area this type of laser is successfully used. The Germans have tested the Ti:Sa laser weapon which took down a drone. The USA army is in the possession of this terrible weapon which in a few seconds disables different military devices/ vehicles.

The laser from Magurele through ELI-NP project is that of sapphire doped with titanium ions. This is based on two big research equipments, a laser system which will generate two 10PW fascicles used with the Linear Accelerator of Tandem Particles 9MV and with research.

My research in the model above would be more complex, and the idea that I might suggest is to be tested: a laser mounted on earth pumps laser radiation to a laser situated on satellite 1 and which excites atoms on a superior level resulting in a population inversion which produces another laser radiation which meets a laser crystal (sapphire doped with trivalent titanium ions Ti^{3+}) situated on satellite 2 and which in his turn following an optical pumping produces a very powerful laser radiation (from close infrared to far infrared) which destroys the enemy rocket almost immediately through warming and explosion.

Such a guidance system of laser radiation used for defense assures the security of strategic military objectives and national security.

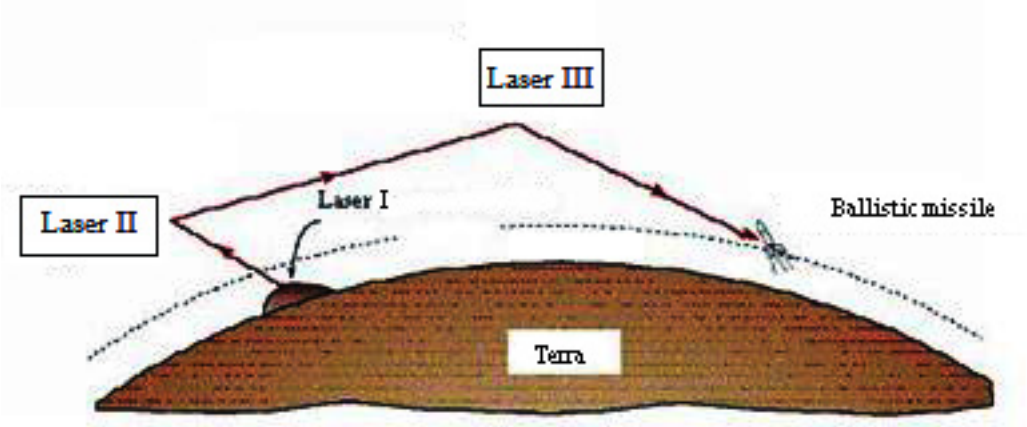

Fig.2 A guidance system of laser radiation.

The method of Brainstorming is used:
- The study method is the Black Box
- What type of laser can be used for the optical pump situated on a high place: Ar-ionized 514-nm laser, Neodim laser which are powerful lasers.
- The phenomenon of amplifying light relies on stimulated emission- the number of atoms/populations is bigger on the superior level (the span of life of the superior Ti: sapphire is short t=3.2 ps) than the lower, phenomenon called population inversion.
- The laser active medium is solid made of the sapphire crystal Al_2O_3 doped with Ti^{3+} titanium trivalent ions.
- The propagation of the laser light is made in a parallel beam. The trajectory of the laser beam is a straight line Ti-Sa east, a tunable laser with the tuning range from 650 nm to 1100 nm.
- The laser beam is a coherent beam, meaning that the wave length is comparable with the stimulating laser wave length.
- The stimulated depopulation/emission of the Hercules laser is made in $\Delta t=10^{-15}s=1fs$, power P=300 terawatts=$300*10^{12}W$, very high energy storage and almost instantaneous release. The laser operation is in ultra short pulses or in pulse regime.
- How many laser types are shown in the figure: there may be at most 3 types from which laser III is the sapphire doped with $Ti:Al_2O_3$ titanium ions.
- The laser beam is very narrow, and the light is monochromatic, meaning that in it there is stored a lot of energy.
- The use of radar for missile identification, screen localization and the use of the laser weapon, guidance for destruction in a very short time.
- The described system is made for ballistic missiles with the help of the missile defense system.
- The satellites have a spy system for the launch base continuous shooting and defense system starting.

3 Developments

Pumping laser analysis: these can be identical or different, the optical pumping can be achieved by the gas lasers, He-Ne or XE laser. This optical pumping is made for the –I ground laser or the laser II on satellite 1. In fact, the system is triggered by two low-powered lasers stimulating a very high-powered laser.

The satellites can be guided on elliptical orbits with the help of lasers. They are in balance when the centrifugal force, outside oriented, given by the satellite speed, is compensated by the gravitational pull force oriented towards Earth, or its center.

The spy satellites are coordinated from the USA defense base, by photographing other states ballistic missiles bases and by giving precise information about the movement in this bases which can trigger an imminent attack in any moment.

The shooting can take place with the laser holograms, made by another laser that can release in a very short time two beams: one on the enemy base, and another on a mirror which is reflected and by interfering with the first gives an answer with a complete image called the laser holography technique. So the hologram is read by the transmitting laser and played by the laser communication to the command center.

The use of laser as a radar, this being the fourth: releases radiation, meets the rocket, then it reflects back recording the detection (location, speed, trajectory) and activates itself with Titanium-Sapphire laser with great force for destruction. The laser action can be of 0-max 30s, when the warming and destruction rocket phenomenon takes place. Everything I described is executed from the command and control base of USA Military Army.

Improving the missile system by rearranging the elements described in the figure or by introducing a detection system.

The laser technique has been improved. A serious analysis reveals that humanity can be destroyed in a few minutes, max. 10 min., using nuclear ballistic rockets. It is very important what professor Stephen Hawkings claimed that information does not disappear from the universe; light does not get out from a black hole. Thus, all information is stocked which represents a great danger for humans in the future. Among many applications of Ti: Al_2O_3 there is in medicine the use of surgical laser in filling teeth.

4 Calculations and results:

It is used multi-criteria analysis**:**

- Alternative A– Ti:Sa laser from Michigan;
- Alternative B- Ti-Sa laser from Magurele;
- Alternative C- Ti-Sa laser from CERN.

Six criteria have been selected:
- Production cost (criterion F) of Ti-Sa laser.
- The power of Ti-Sa laser (criterion P);
- Security (criterion S);
- Behavior in fine weather (criterion VS);
- Behavior in wet/cloudy weather (criterion VU);

- Emission of laser radiation is achieved in short pulses, intermittently (criterion E).

FRISCO [8] formula is used to calculate weight coefficients:

$$\gamma_i = \frac{p + \Delta p + m + 0.5}{-\Delta p' + \frac{N_{crt}}{2}}.$$

Table 1. Weight Criteria

	F	**P**	**S**	**VS**	**VU**	**PS**	**p-cte**	**Nivel**	**ɣ(i)**
F	1/2	1	0	0	0	0	1,5	5	0.5
P	0	1/2	1/2	0	0	0	1	6	0,2
S	1	1/2	1/2	0	0	0	2	4	0,85
VS	1	1	1	1/2	1	1	5,5	1	5,17
VU	1	1	1	0	1/2	0	3,5	3	1,9
PS	1	1	1	0	1	1/2	4,5	2	3,13

Table 2. Giving a mark

	Variant (a)	Variant (b)	Variant (c)
Criteria	N(i)	N(i)	N(i)
F	10	6	7
P	10	5	5
S	10	10	10
VS	10	10	10
VU	9	9	9
PS	10	10	10

Table 3. Final ranking

		Alternative A		Alternative B		Alternative C	
Criteria	**ɣ(i)**	N(i)	N(i)X **ɣ(i)**	N(i)	N(i)X **ɣ(i)**	N(i)	N(i)X **ɣ(i)**
F	0.5	10	5	6	3	7	3,5
P	0,2	10	2	5	1	5	1
S	0,85	10	8,5	10	8,5	10	8,5
VS	5,17	10	51,7	10	51,7	10	51,7
VU	1,9	9	17,1	9	17,1	9	17,1
PS	3,13	10	31,3	10	31,3	10	31,3
Final ranking			**115,6**		**112,6**		**113,1**

5 Conclusions

The calculation of the results between N marks and weight coefficients is successfully accomplished in a table which is defined as " the matrix of consequences" where the final ranking among A,B,C alternatives is established, the first place being taken by the laser from Michigan, with an importance coefficient equal to 115,6. Advanced multi-criteria analysis had at least 6 criteria (production cost, the power of Ti-Sa laser, security, behavior in fine weather, behavior in wet/cloudy weather, emission of laser radiation). The defense technique using laser weapon against missiles is successfully assured.

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